THE ART OF DIALLING,

By a New, Easie, and most Speedy Way.

SHEWING,

How to describe the *Hour Lines* upon all sorts of *Plains*; Howsoever, or in what *Latitude* soever, situated.

ALSO;

To find the HOUR of the *Day*, and the AZIMUTH of the *Sun*, whereby the *Sight* of any *Plain* is Examined.

Performed by a *Quadrant* filled with Lines necessary to that purpose.

Invented and Published in *Anno* 1638. by SAMUEL FOSTER, then Professor of Astronomie in *Gresham* Colledge.

The Second Edition,
With several *Additions* and *Variations* of the Authors, deduced from his own Manuscript.

With a SUPPLEMENT, Performing all the Instrumental Work of the Quadrant, by Calculation. By help of the Canons of Sines and Tangents, which of all ways is the most Exact.

By WILLIAM LEYBOURN Philomath.

LONDON,
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Mr. SAMUEL FOSTER

HIS

PREFACE

TO THE

READER.

READER,

HEre is preſented to thy view a ſhort and plain Treatiſe; it was written for mine own uſe, it may become thine if thou like it; The ſubject indeed is old; but the manner of the Work is all new. If any be delighted with recreation of this nature, and yet have not much time to ſpend, they are here fitted, the Inſtrument will diſpatch preſently. If they fear to loſe themſelves in a wilderneſs of lines, or to out-run the limits of a Plain, by infinite excurſions (two inconveniences unto which the common wayes are ſubject) they are here acquitted of both, having nothing to draw but the Dial it ſelf, contracted within a limited equicrural triangle. If want of skill in the

Mathematicks ſhould deterr any from this ſubject, let them know, that here is little or none at all required, but what the moſt ignorant may attain. If others ſhall think the Canons more exact, ſo do I, but not ſo eaſie to be underſtood, not ſo ready for uſe, not ſo ſpeedy in performance, nor ſo well fitting all ſorts of men: and withall an Inſtrument in part muſt be uſed, this will do all, and is accurate enough. If it muſt needs be diſliked, let a better be ſhewed, and I will diſlike it too; It is new, plain, brief, exact, of quick diſpatch. Accept it, and uſe it, till I preſent thee with ſome other thing, which will be ſhortly.

Greſham Colledge
Decemb. 1. 1637.

SAM. FOSTER

WILLIAM LEYBOURN
TO THE
READER.

THE following Treatiſe (*though with other Lines upon the Inſtrument, and by a different manner of working with them*) *was publiſhed in* Anno 1638, *by the Author and Inventer thereof,* Mr. Sam. Foſter, *an Account whereof himſelf hath given you in his fore-going* Epiſtle to the Reader, *and the* Demonſtration *of that his Invention is publiſhed in* Latine *among his* Miſcellanies, *wherefore I ſhall ſay nothing of it in this place, but give you an account of his improvement of the ſame ſince its firſt publication; and that briefly.*

Firſt, The former Quadrant *had Lines or Scales, deſcribed on both* Faces *of the* Inſtrument, *and thoſe not a few. This his* Improvement *hath reduced all the Lines, or Scales, to one* Face *or* Side, *and the number of them is leſſened by one half; which will render this* Quadrant *much cheaper than the other, and yet the* Uſes *performed by it are the ſame, and may be wrought upon it with the like* facility *and* Exactneſs. *Thus for the* alteration *of the* Inſtrument.

Secondly, For the Book. The Lines and Scales upon the Inſtrument *being thus changed, the manner of*

working *by them, muſt neceſſarily differ alſo; wherefore, in this* Treatiſe, *the* Diagrams *and* Examples *remain the ſame, but the Firſt, Second, and Third Chapters are wholly new: The fourth and fifth continue the ſame: the ſixth and ſeventh wholly new: The eighth the ſame as before: The ninth, tenth, and eleventh are in part varied: And the twelfth Chapter remains the ſame, only the work of the ninth* Section *thereof is otherwiſe performed: But in the* Appendix *there is no alteration at all. And this is a true account of the Variations both of the* Inſtrument *and* Book, *which I have faithfully publiſhed by his own* Manuſcript, *under his own hand. It reſteth now that I ſay ſomething concerning the* Supplement *by me added.*

Mr. Foſter, *in his foregoing* Epiſtle *to the* Reader, *hath theſe words*; If others ſhall think the Canons more Exact, ſo do I, *&c. From whence you may gather, that he preferred* Arithmetical calculation *before* Inſtrumental operation, *although,* (*in that caſe*) an Inſtrument in part muſt be uſed. *I have therefore unto all his Inſtrumental Workings, framed* Canons, *whereby they may be wrought by the* Tables *of* Artificial Sines *and* Tangents, *which performance, of all others, is the moſt exact, and may be of good uſe, both when an* Inſtrument *may be wanting, or when you have wrought by your* Inſtrument, *to Examine the truth of your work. Thus, by the addition of this* Supplement, *you have not only an* Inſtrumental, *but an* Arithmetical *way of* Dialling *alſo correſponding thereunto: both which I commend unto thee, and bid thee Farewell.*

London,
Aug. 23. 1675.

W. LEYBOURN.

In Mr. Foſter's *Appendix to this Book, he hath there ſhewed how to find the Latitude of any place by the North Star, but that way cannot be conveniently put in practice at all times by all ſorts of perſons, wherefore I have here added a Table of the Latitudes of all principal places in* England, Scotland, *and* Ireland.

England.	D	M
Bedford	52	8
Barwick	55	54
Briſtol	51	57
Buckingham	52	0
Cambridge	52	12
Canterbury	51	17
Carliſle	55	0
Chicheſter	50	48
Cheſter	53	16
Colcheſter	51	58
Derby	52	58
Dorcheſter	50	40
Durham	54	50
Exceſter	50	43
Gilford	51	12
Gloceſter	51	53
Hartford	51	49
Hereford	52	7
Huntington	52	19
Ipſwich	52	8
Kendal	54	23
Lancaſter	54	10
Leiceſter	52	40

England.	D	M
Lincoln	53	14
London	51	32
Northampton	52	14
Norwich	52	42
Nottingham	53	0
Oxford	51	46
Reading	51	28
Salisbury	51	4
Shrewsbury	52	47
Stafford	52	52
Stamford	52	38
Truero	50	30
Warwick	52	20
Wincheſter	51	3
Worceſter	52	14
York	53	58

Wales.	D	M
Angleſey	23	28
Barmonth	52	50
Brecknock	52	1
Cardigan	52	12
Carmarthen	51	56
Carnarvan	53	16

Denbigh

Wales.	D	M
Denbigh	53	13
Flint	53	17
Llandaffe	51	35
Monmouth	51	51
Montgomery	51	56
Pembroke	51	46
Radnor	52	19
St. David	52	0

Iſlands.	D	M
Arnſey	49	30
Jerſey	49	12
Limdy	51	22
Man	54	24
Portland	50	30
Wight	50	39

Scotland.	D	M
Aberdeen	57	32
Dunblain	56	21
Dunkel	56	48
Edenburgh	55	56
Glaſcow	55	52
Kinſaile	57	44
Orkney	60	6
Scotland.	D	M
St. Andrews	56	39
Skyraſſin	58	36
Sterling	56	12

Ireland.	D	M
Antrim	54	38
Arglas	54	10
Armagh	54	14
Caterlagh	52	41
Clare	52	34
Corke	51	53
Droghedagh	53	38
Dublin	53	13
Dundalke	53	52
Galloway	53	2
Youghall	51	53
Kenny	52	27
Kildare	53	0
Kingſtown	53	8
Knockfergus	54	37
Kynſale	51	41
Lymerick	52	30
Queens Town	52	52
Waterford	52	9
Wexford	52	18

THE

A TABLE

Of the Latitude of the moſt eminent Places in *England*, *Wales*, *Scotland* and *Ireland*.

	d.	m.
Bedford	52	8
Barwick	55	54
Briſtol	51	27
Buckingham	52	
Cambridge	52	12
Canterbury	51	17
Carliſle	55	
Chicheſter	50	48
Cheſter	53	16
Colcheſter	51	58
Derby	52	58
Dorcheſter	50	40
Durham	54	50
Exceter	50	43
Gilford	51	12
Glouceſter	51	53
Hartford	51	49
Hereford	52	7
Huntington	52	19
Ipſwich	52	8
Kendal	54	23
Lancaſter	54	10
Leiceſter	52	40
Lincolne	53	14
London	51	32
Northampton	52	14
Norwich	52	42
Nottingham	53	
Oxford	51	46
Reading	51	28
Salisbury	51	4
Shrewsbery	52	47
Stafford	52	52
Stamford	52	38
Truero	50	30
Warwick	52	20
Wincheſter	51	3
Worceſter	52	14
Yorke.	53	58

WALES	d.	m.
Anglezey	53	28
Barmouth	52	50
Brecknock	52	1
Cardigan	52	12
Carmarthen	51	56
Carnarvan	53	16
Denbigh	53	13
Flint	53	17
Llandaffe	51	35
Monmouth	51	51
Montgomeroy	51	56
Pembrooke	51	46
Radnor	52	19
St. David	52	00

The ISLANDS.	d.	m
Garnzey	49	30

	d.	m.
Jersey	49	12
Lundy	51	22
Man	54	24
Portland	50	33
Wight Isle.	50	39

SCOTLAND.	d.	m.
Aberdean	57	32
Dunblain	56	21
Dunkel	56	48
Edinburgh	55	56
Glascow	55	52
Kintaile	57	44
Orkney Isle	60	6
St. Andrewes	56	39
Skiraſſin	58	36
Sterling.	56	12

IRELAND.	d.	m.
Antrim	54	38
Arglas	54	10
Armach	54	1
Caterlagh	52	41
Clare	52	3
Corke	51	5
Droghedah	53	38
Dublin	53	1
Dundalk	53	5
Galloway	53	2
Youghal	51	5
Kenny - *Kill-*	52	2
Kildare	53	0
Kings towne	53	8
Knock fergus	54	3
Kynſale	51	4
Lymerick	52	3
Queens towne	52	5
Waterford	52	9
Wexford.	52	1

A Tab

THE DESCRIPTION AND USE OF A QUADRANT,

By which *HOURE-LINES* may be deſcribed upon all ſorts of *PLAINS*, Howſoever, or in what Latitude ſoever, ſituated.

CHAP. I.

A Deſcription of the Lines upon the Quadrant.

THE Quadrant hath Lines deſcribed only upon one ſide, the other being left free for any other Uſe; The Limb below is divided into 90 deg. and ſubdivided into as many parts as quantity will give leave: The manner of diviſion and diſtinction of the ſubdivided parts, is ſuch as is

uſual in all other Quadrants; but in this the Numeration is both wayes, and the Characters of the twelve Signes are ſet thereunto in their due places.

Without this Limb, is a Circular Scale of the Sun's Declination, the making whereof (with its uſe) is ſhewed in the third and fourth Sections of the *APPENDIX*.

Within the Limb is deſcribed the Quadrant, *m* O A B C B A, which is divided into Six equal parts: From the firſt of them at O, to the Centre, draw O C, and let the diviſions at A, B, C, B, A, be numbred with 15, 30, 45, 60, and 75.—— Then from *m*, to the fartheſt A, draw the ſhort right Line *m* A; and from the point A 15, to A (upon the Line C O) draw A *e*; and a Ruler laid from *e* to C 45, will give the Line *e* C.——Then again, make *m t* equal to OC, and lay a Ruler from *t* to B 30, the ſame ſhall give the Line *t* B; and from B, to B 60, a Ruler laid will make the Line B *n*; ——And laſt of all, draw *n* O, ſo ſhall that croſs Work be perfected: Only below, you are to divide the Ark O *m* into 15 degrees, and number them from O towards *m*, by 5, 10, 15.

The two ſides of the Quadrant have each their Scale annexed; The ſide D *m*, hath upon it a Scale of *Natural Tangents*, from 00 *deg.* to 63 degrees 27 min. (which is the double Radius.)—— The Side D A hath a Scale of *Verſed Sines*, numbred to 180 degrees; and in the midſt of it, to the length of 23 ½ *deg.* on both ſides 90, is added a *Zodiac Scale*, which is nothing elſe but a double Radius, or a *double Line of Sines*, diſtinguiſhed into ſuch kind of

of Diviſions as is moſt ſuitable to the numeration of the 12 Signes.

The Line DB (drawn about the middle of the Superficies of the Quadrant) is to be a *Line*, or *Scale*, of *Latitudes*, to the length whereof, having a *Decimal Scale* equal, you muſt divide the Line DB into ſuch parts as this Table here following alloweth; the Numbers beginning at B, and riſing up to 90 at D.

The *Scale* of *Tangents* D*m*, and the *Scale* of *Verſed Sines* D A, are each of them divided out of their reſpective *Tables* of *Natural Sines* and *Tangents* (which are in every mans hands) by help of *Diagonall Scales* made equal to the ſemi-radius of the Quadrant.

A Table to divide the Line of Latitudes.

90	10000	62	9360	46	8259	30	6325	14	3325
85	9982	61	9311	45	8165	29	6169	13	3104
80	9924	60	9258	44	8068	28	6010	12	2879
78	9888	59	9203	43	7968	27	5846	11	2650
76	9849	58	9147	42	7865	26	5678	10	2419
75	9825	57	9088	41	7758	25	5505	9	2186
74	9801	56	9026	40	7647	24	5328	8	1949
72	9745	55	8962	39	7532	23	5146	7	1711
70	9685	54	8895	38	7414	22	4961	6	1470
69	9651	53	8825	37	7292	21	4772	5	1228
68	9615	52	8753	36	7166	20	4577	4	984
67	9578	51	8678	35	7036	19	4378	3	739
66	9539	50	8600	34	6902	18	4176	2	493
65	9496	49	8519	33	6764	17	3969	1	247
64	9454	48	8436	32	6622	16	3758	0	0
63	9408	47	8348	31	6475	15	3543		S.F.

Upon your Inſtrument (for memory, and directions ſake) near to the Line D*m*, write *The Scale of Tangents*. Near to DA write *The Scale of Verſed Sines*. Near to the ſmall double Scale of Sines, write *Zodiac*, And near to the Line DB, write *The Scale of Latitudes*. All theſe particular diſtinctions you ſee done in the Scheme of the Inſtrument hereunto annexed, and unto this (as unto all other Quadrants) there belongs a pair of *Sights*, and a *Line* and *Plummet*, and ſo is your *Inſtrument* compleated to perform the work intended to be performed by it.

CHAP. II.

Of the Quadrants *Uſe in general.*

ALL Works upon the Quadrant are performed by a pair of *Compaſſes* and a Thread, uſed (for the moſt part) together with the *Scales*.

The Scale of *Verſed Sines* ſerveth in general;

1. By having the three ſides of a *Spherical Triangle*, to find an *Angle*,

2. By having two *Sides* and the *Angle included*, to find the *Baſe*.

But it is here principally intended for the ſole work of finding the *Azimuth* of the *Sun*, and the *Hour* of the *Day*, as in the next Chapter is ſhewed; and for this cauſe is it, that the *Zodiack Scale* is annexed thereunto.

The

The Scale of *Tangents* taken with the *Limb*, is to work proportions in *Sines* and *Tangents*, many of which *Proportions* come to be wrought in this *Treatiſe*, as will appear afterwards.

CHAP. III.

The uſe of the Scale of Verſed Sines.

§. I. *To find the Suns* Azimuth, *in any Latitude.*

FIrſt gather the Sum and the Difference of the Complement of your Latitude, and the Complement of the Suns Altitude; then count theſe two (the Sum and Difference) upon the Verſed Scale of Sines, and with your Compaſſes take their diſtance. After this, ſet one foot of this your extent upon the point of 180 degrees, and with the other foot turned about, lay the thread to its due poſition, where keeping it faſt, take the diſtance (upon the Scale) between the forenamed Sum, and the Suns place in the Zodiac, and enter that diſtance between the Scale and the thread (according to the leaſt diſtance, as the manner is) and that foot of the Compaſſes which ſtandeth upon the Scale, will there ſhew the *Azimuth*, of the Sun from the *South*.

Example 1. In the Latitude 52 *de.* 30 *m.* the Suns altitude being 30 *de.* 45 *m.* and the Sun in the

the beginnig of *Taurus* ♉. I would know the *Azimuth* from the ſouth.

	d.	*m.*
The complement of the Latitude is——	37	30
The complement of the Suns Altitude is	59	15
Their Sun—	96	45
Their difference	21	45

Upon your Verſed Scale take with your Compaſſes the diſtance between *96 de.* 15 *m.* and 37 *de.* 30. *m.* and ſet one foot of that extent in 180 *deg.* bringing the thread to the neareſt diſtance of the moveable point of the Compaſs, and there keep the thread faſt.— Then with your Compaſſes take the diſtance between the Sum *96 de.* 45 *m.* and the beginning of ♉ *Taurus*, in the Zodiac, and with this diſtance move one foot of the Compaſſes upon the Verſed Scale, till the other being turned about do only touch the thread, ſo ſhall you find the other point to reſt upon the Verſed Scale at *66 deg.* 48 *min.* which is the *Azimuth* from the South.

Example 2. And thus the Latitude and the Suns place being the ſame, and the Altitude *9 de.* 15 *m.* the *Azimuth* from the South will be found to be *96 deg.* 52 *min.*

Example 3. Again, In the ſame Latitude, the Sun being in 10 *deg.* of ♏ *Scorpio*, and his Altitude *9 de.* 30 *min.* the Suns *Azimuth* from the South will be found to be *49 de.* 50 *m.*

§. 2. *To*

§. 2. *To find the* Hour of the day *in any Latitude.*

The Propoſition in the foregoing Section is abſolutely neceſſary for the making of Dials, to find thereby the ſituation of the plain upon which the Dial is to be made.

This Propoſition is here added (not that there is any need of it in the making of the Dial, but) becauſe it will be uſeful to try any Dial, after it is made, how true it goes: And to find the true hour

Firſt, Seek the Suns place in the appendent Zodiac, and you ſhall ſee to what degrees in the Verſed Scale it pointeth, for thoſe degrees do give the Suns diſtance from the North Pole, (or the Complement of the Suns declination.)

Secondly, Compare the Suns diſtance from the Pole, and the Complement of your Latitude together and find the ſum and difference of them.

Thirdly, Upon the Verſed Scale, count this Sum and Difference, and take their diſtance, and ſetting one foot of the Compaſſes in 180 deg. bring the thread to the neareſt diſtance, and there keep it.

Fourthly, Take the diſtance between the former difference, and the Complement of the Suns Altitude, and enter that extent between the Scale and the thread, ſo will that foot upon the Scale ſhew how many degrees the Sun is diſtant from the South part of the Meridian. —— An hour conſiſts of 15 *deg.* and one degree is equal to 4 minutes of time, and by this allowance, the former degrees of the

the Sun from the Meridian may be turned into hours and minutes of Time.

Example 1. The Latitude is 51 *de.* 30 *m.* the Suns place is the beginning of ♉ *Taurus*, and the Altitude of the Sun is 35 *deg.* and let the *Hour* be required.

	d.	*d.*	*m.*
From the beginning of the Scale to 00 of *Taurus* is		78	30
The Complement of the Latitude		38	30
Their Sum	117	00	
Their difference	40	00	

Take the diſtance between 117 *deg.* and 40 *deg.* and ſet one foot in 180 *deg.* and turning the other about, bring the thread to the neareſt diſtance, and there keep it.——Then take the diſtance from 40 (the difference) to 55 (the Complement of the Altitude,) and enter this diſtance between the *Verſed Scale* and the thread, ſo ſhall the point that moved upon the *Verſed Scale*, reſt upon 46 *de.* 52 *m.* and ſo many degrees is the Sun diſtant from the South part of the Meridian.

Theſe 46 *deg.* 48 *m.* converted into time (by the former Rule) make 3 hours 7 ½ minutes: So that if the obſervation were made in the Afternoon, the hour of the day would be 7 minutes after 3.-But if it were made in the Forenoon, then the hour of the Day would have been 53 min. after 8.

There

There are many more particular uſes of this *Verſed Line*, ſutable to the Two general *Propoſitions* mentioned in the preceedent ſecond *Chapter*. But theſe ſhall ſerve in this place.

CHAP. IV.

To find out the Declination *of a Plain.*

THE *Declination of a Plain* is numbred from the South or North Points, towards either Eaſt or Weſt. And it is the ark of the Horizon comprehended between the South or North, and a Line infinitely extended upon the Horizon perpendicular to the Horizontal Line of the Plain, which Line may be called the *Axis*, and the extremity of it, the *Pole of the Plains Horizontal Line.*

To find out this *Declination*, You muſt make two Obſervations by the Sun: The Firſt is of the *diſtance*, or Angle made between the Axis of the Horizontal Line of the Plain, and the *Azimuth* wherein the Sun is at the time of Obſervation. The Second is of the Suns Altitude. Both theſe Obſervations ſhould be made at one inſtant, which may be done by two Obſervers, but if they be made by One, the leſs diſtance of time between them, will make the Works to agree together the better.

1. For the *Diſtance*. Upon your Plain, draw a Line parallel to the Horizon, to this Line apply the

ſide of your Quadrant, holding it parallel to the Horizon, Then holding up a *Thread* and *Plummet*, which muſt hang at full liberty, ſo as the Shadow of the Thread may paſs through the Center of the Quadrant: Obſerve the Angle made upon the Quadrant by the Shadow of the Thread, and that ſide that lyeth perpendicular to the Horizontal line; for that Angle is the *diſtance* required.

2. At the ſame inſtant(as near as may be)take the Suns Altitude; Theſe two being heedfully done, will help you to the Plains Declination by theſe *Rules* following.

When you have taken the Altitude, you may find the Suns *Azimuth* by the former Chapter. Then obſerve whether the Sun be between the Pole of the Horizontal Line, and the {South / North} point, or not.

If the Sun be between them, *adde* the *Azimuth* and *Diſtance* together, and the *Sum* of them is the *Declination of the Plain.*

If the Sun be not between them, *ſubduct* the leſſer of them from the greater, and the *Difference* ſhall be the *Declination of the Plain.*

¶ *By your Obſervation you may know to what Coaſt a Plain declineth.*

For, if the {South / North} Point be in the *midſt*, between the *Suns Azimuth* and the *Pole of the Plains Horizontal Line*; then doth the Plain decline to the *Coaſt contrary* to that wherein the Sun is; If otherwiſe

wiſe, the *Declination* is upon the *ſame Coaſt* with the Sun.

CHAP. V.

To find the Inclination *of a Plain.*

FIG. I.

THE Inclination of a Plain is the Angle that the Plain maketh with the Horizon. When you have deſcribed your Horizontal Line upon a Plain, as in this Figure E F. croſs it with a Perpendicular G H, for the *Vertical Line.*

And becauſe the Inclination of the Upper, and Under faces of the Plain, are both of one Quantity in themſelves; if therefore you apply the Side of the Quadrant noted with A B unto the *Vertical Line* of the *Under Face*, or to the under ſide of a *Ruler* applyed to the *Vertical Line* of the *Upper Face*, as is here ſhewed in this *Figure*; Then ſhall the degrees of the *Quadrant* give you C A D the *Angle* of the *Plains Inclination* required.

CHAP. VI.

Of Upright Declining *Plains.*

THoſe Plains are upright, which point up directly into the Zenith, or Vertical Point of the Horizon, and may be tryed by a Perpendicular, or Plumb Line. In theſe (as in the reſt which follow) before the Hours can be drawn, Two things muſt be found;

1. *The Plains difference of Longitude.*
2. *The Height of the Pole above the Plain.*

The finding of theſe two *Requiſites*, and alſo thoſe which follow in the VII, IX, and XII Chapters, are performed by working of *Proportions* in *Sines* and *Tangents*, by help of the *Tangent Line* and the *Equal Limb* of the *Quadrant*, in the performance whereof.

¶ Note I. That the firſt work (in every particular Proportion ſet down in this and in the VII, IX, and XII Chapters) of counting in the Limb, and laying the Thread thereunto, muſt always be underſtood thus; viz. *The Numeration muſt begin upon that end of the Limb, on which the Scale of* Tangents *ſtandeth.*

¶ Note II. That in all the following Works by the *Tangent Line*, I have ſet down Two ways of Working, not that both ſhould be uſed at all times; but in caſe one fail, the other may hold

hold good. For the *Tangent Line* being of it ſelf *infinite*, cannot be made to contain all the 90 *deg.* which cauſeth it ſometimes to happen, that the numbers *given* and *required*, which will not be found upon the *Line* by the *Firſt* way, may eaſily be ſupplied by the *Second*.

§. I. *To find the difference of the Plains Longitude.*

Count your Latitude in the Quadrants Limb, and thereto lay the Thread; then chooſe one of theſe two wayes, that which is moſt fit for the Scale; namely,

1. Either, Take the Tangent of the Plains Declination, and enter it between the Tangent Scale and the Thread, ſo ſhall the foot of your Compaſſes upon the Scale, give the *Difference of Longitude*.

2. Or elſe, The Thread lying as before; Count the Complement of the Plains Declination upon the Tangent Line, and there ſetting one Foot of your Compaſſes, take the leaſt diſtance to the Thread, and meaſure this Diſtance, upon the Scale of Tangents, where it will ſhew the *Complement of the Plains Difference of Longitude*.

§. II. *To find the Poles Elevation above the Plain.*

Lay the Thread to the Complement of the Plains difference of Longitude counted in the Limb. Then,

1. Either

1. Either counting the Complement of your Latitude upon the Tangent Line, from thence take the leaſt diſtance to the Thread, and meaſure that diſtance upon the Scale of Tangents, which will here ſhew the *Poles Elevation.*

2. Or elſe, Take the Tangent of your Latitude, and enter that length between the Tangent Scale and the Thread; ſo the foot that ſtandeth upon the Scale ſhall there ſhew the *Complement of the Poles Elevation.*

According to theſe Rules, in the Latitude of 52 *deg.* 30 *min.* ſuppoſing an upright Plain to decline 55 *deg.* 30 *min.* I find *the Plains difference of Longitude* to be 28 *deg.* 37 *m.*—— And *the Elevation of the Pole above the Plain* to be 20 *deg.* 10 *min.*

CHAP. VII.

Of Eaſt and weſt Incliners.

THoſe Plains are called Eaſt and Weſt Incliners, whoſe Horizontal Line lyeth full North and South, and their inclination is directly towards either Eaſt or Weſt. And before theſe Dials can be drawn, two things (as in upright Plains) muſt be found.

§. I. To

§. I. *To find the Plains difference of Longitude.*

Count the Complement of your Latitude in the Limb, and lay the Thread there. Then,

1. Either take the Tangent of the Plains Inclination, and enter it between the Scale and the Thread, by which work you ſhall find the *Difference of Longitude.*

2. Or elſe. Upon the Scale of Tangents, count the Complement of the Plains Inclination, and from thence to the Thread take the neareſt diſtance, this length meaſured upon the Scale of Tangents, gives the *Complement of the Plains Difference of Longitude.*

§. II. *To find the Elevation of the Pole.*

Count the Complement of the difference of Longitude (which was found before) upon the Limb, and there lay the Thread. Then,

1. Either, Take the Co-tangent of your Latitude, and enter it between the Scale and the Thread, that the foot upon the Scale may give the *Complement of the Poles Elevation.*

2. Or elſe, Count the Latitude of your Place upon the Scale of Tangents, and from thence to the Thread take the leaſt diſtance; this length meaſured upon the Scale of Tangents, will give the *Elevation of the Pole.*

Thus in the Latitude of 52 *deg.* 30 *m.* if a Plain Incline Eaſtward 40 *deg.* to the Horizon, the Plains *difference of Longitude* will be found

to

to be 54 *d.* 2 *m.* And *the Elevation of the Pole* 37 *deg.* 26. *m.* above the Plain.

CHAP. VIII.

In North and South Incliners.

SUch Plains are called North and South Incliners, whoſe Horizontal Line lyeth full Eaſt and Weſt, and their Inclination is directly upon either North or South.

1. *For the Plains difference of Longitude.*

There is no uſe of it in theſe Plains, becauſe they all lie directly under the Meridian of the place.

2. *To find the Elevation of the Pole above the Plain.*

If the Inclination be toward the South, add the Inclination to your Latitude; for the ſum is the *Elevation of the Pole* above the Plain. If the ſum exceed 90 degrees, take it out of 180, and the ſupplement gives you the *Poles Elevation.*

If the Inclination be Northward, compare the Inclination with your Latitude, and ſubduct the leſſer out of the greater; the Difference is the *Elevation of the Pole above the Plain*; If there be no difference, it is a *direct Polar Plain.*

CHAP. IX.

Of Declining Incliners.

THoſe Plains are called Declining Incliners, whoſe Aſpects are not juſtly upon any of the four Cardinal Coaſts, neither are their Superficies upright upon, but Inclining towards the Horizon.

The beſt way to find the *Difference of Longitude*, and the *Poles Elevation* due to ſuch Plains, will be

Firſt, To refer them to a *New Latitude*, wherein they may lie as Eaſt or Weſt Incliners. For which purpoſe you are firſt to find out an Ark, which in reſpect of its uſe may fitly be called, *The Proſthaphæretical Ark*, it is found by this rule:

§. I. *To find the Proſthaphæretical Ark.*

Upon the Limb count the Complement of the Plains Declination, and thereto lay the Thread. Then.

1. Count the Plains Inclination to the Horizon upon the Scale of Tangents, and from thence to the Thread take the leaſt diſtance, and meaſure it upon the Tangents, it will there give the *Proſthaphæretical Ark* required.

If you take the Complement of the Inclination (from the Scale of Tangents) and enter it between the Scale and the Thread, it ſhall there ſhew (upon

the ſame Scale) the *Complement* of the *Proſthaphæretical Ark*.

¶ This *Proſthaphæretical Ark* is to be uſed as the Inclination was in the precedent Chapter. For,

If the plain do incline towards the South, it muſt be added to your Latitude: and ſo the ſum (if leſs than 90 degrees) gives you the *New Latitude*; but if the ſum be greater than 90, then the reſidue, or ſupplement of it to 180 degrees will be the *New Latitude* required.

If the Plain incline toward the North, compare this *Proſthaphæretical Ark* with your Latitude, and ſubduct the leſſer of them out of the greater; So the Difference ſhall give you the *New Latitude*. If there be no difference, it is a declining *Polar Plain*.

Secondly, It will be required to know what Inclination theſe Plains ſhall have in this their *New Latitude*; and that is done by this rule:

§. II. *To find the Plains new Inclination.*

Lay the Thread upon the *Proſthaphæretical Ark* counted in the Limb. Then,

1. Count the Declination of the Plain upon the Scale of Tangents, and from thence to the Thread take the leaſt diſtance, and meaſure the ſame upon the Tangent Scale, where it will ſhew the *New Inclination* of the Plain.

2. Or take the Co-tangent of the Plains Declination and enter it between the Scale and the Thread, then will the Foot that ſtandeth upon the Tangent

Tangent Scale, ſhew the *Complement* of the *Plains New Inclination.*

¶ After theſe things are done, you may proceed to work as in other Plains is required.

§. III. *To find the Difference of Longitude.*

Count the Complement of the new Latitude upon the Limb, and there lay the Thread. Then,

1. Either take the Tangent of the Plains new Inclination, and enter it between the Scale and the Thread, that the foot upon the Scale may give the *Difference of Longitude.*

2. Or, Upon the Scale of Tangents, count the Complement of the Plains New Inclination, and from thence take the leaſt diſtance to the Thread, for this diſtance meaſured upon the Scale of Tangents gives the *Complement* of the *Plains difference of Longitude.*

§. IV. *To find the Elevation of the Pole.*

In the Limb count the Complement of the Plains difference of Longitude (which was found before.) Then,

1. Either take the Co-tangent of the New Latitude, and enter it between the Scale and the Thread, that the foot upon the Scale of Tangents may ſhew the *Complement of the Poles Elevation.*

2. Or elſe, From the New Latitude (counted upon the Scale of Tangents) to the Thread, take the leaſt diſtance; This meaſured upon the Tangent Scale gives the *Elevation of the Pole.*

According to theſe Rules, ſuppoſing a Plain to Incline towards the North 30 *deg.* and to decline from the South towards the Weſt 60 *deg.* in the Latitude of 52 *deg.* 30 *m.* you ſhall find,

	de.	*m.*
1. The *Proſthaphæretical Ark*	16	06
And becauſe the Plain Inclineth towards the North, I compare this Ark with the Latitude of the place, and taking it out of the Latitude there remains for		
2. The New Latitude	36	24
3. The New Inclination	25	40
4. The Difference of Longitude	30	52
5. The Elevation of the Pole above the Plain	32	20

CHAP. X.

To draw the Hour Lines upon the Horizontal, the full North or South Plains, whether ſtanding upright or inclining.

FIG. II.

IN the four laſt Chapters we have ſeen the uſes of the Line of Tangents and the Equal Limb, in this and the next Chapter we ſhall ſhew the uſe of D B the Line of Latitudes, and of the Limb, *m* O A B C B A with the Croſs or Network *t* C *m* O, which with the help of the Thread and a pair of

of Compaſſes, will ſerve to prick down any Dial, by the Precepts hereafter delivered. And firſt we begin with thoſe Plains which have no declination, whoſe Poles lie directly under the Meridian of the place; of which ſort are the Horizontal, the Erect South and North Plains, with all Incliners looking directly North or South.

Having then by the former Precepts found the *Elevation of the Pole above your Plain*, you may begin your draught in this manner.

For an Horizontal Dial.

1. Draw the Line R A T of ſufficient length, and out of the Line of Latitudes in your Quadrant, take off the Elevation of the Pole above the Plain, and prick it down from the point A, unto R and T both ways.

2. Take the diſtance between A 75, and *m* out of the Quadrant, and with that extent of your Compaſſes upon R and T as upon two centers, draw the arks B V and C V, croſſing each other in V; and draw the Lines R V and T V: then coming to your Quadrant again.

3. The ſpace from A 15 to A, upon the Line C O, ſets off upon the Dial V 1. V 11. R 5. T 7.---- From B 30. to B upon the Line C O, ſets of V 2. V 10. R 4. T 8 ——From C 45. to C upon the Line C O, ſets off V 3. V 9. or R 3. T 9.

Laſtly then. Laying your Ruler to the center A, through each of theſe points, you ſhall draw the Hour Lines A 7 A 8. A 9, A 10, A 11, A V which is 12, A 1, A 2, A 3, A 4, A 5, R A T is the Line of the two ſixes. So having 12 Hours, which is half

half the Dial, drawn, you may extend the neceſſary Line, as many as you will, beyond this Center, as 5A5, 4A4, 7A7, 8A8, &c.

For the half Hours and Quarters uſe the Thread in ſuch manner, as ſhall be ſhewed in the other Dials following.

And note alſo that in theſe Plains before mentioned; As the extent from V to 1, is the ſame with that from T to 7, ſo likewiſe is it the ſame with V 11, R 5; And as V 2 is the ſame with T8, ſo likewiſe is it the ſame with V 10, R 4: So likewiſe V 9 and T 9 are all one, and both equal to R 3, and V 3. So that the three firſt Hours taken from the Quadrant, that is to ſay, From A 15 to A, from B 30 to B, from C 45 to C, will give all the Hours from theſe Dials. A 15, A gives V 1, V 11, R 5, T 7. B 30, B gives V 2, V 10, R 4, T 8. C 45. C gives V 3 or R 3, V 9 or T 9. But in other Plains it is not ſo, for which cauſe I have rather ſet down this way before at length, as a direction for what comes after, for that is general.

Here note again, that if you deſire to make your draught greater, you may in your deſcription either double or triple every length which you take in your Compaſſes. And ſo I proceed to all declining Plains.

CHAP.

CHAP. XI.

To draw the Hours upon all ſorts of declining Plains, whether erect or inclining.

FIG. III.

BY the former precepts you muſt firſt get the *Plains Difference of Longitude*, with the *Elevation of the Pole above the Plain.* After they are had, you may prick down the Hour points in this manner following, little differing from the former.

1. As before; Upon the Line R A T, ſet off the Elevation of the pole above the plain, being taken out of the Line of Latitudes in the Quadrant, from A both ways, to R and T.

2. Take the Line A 75, *m* out of the Quadrant, and with that extent upon R and T as upon two centers, deſcribe the two arks BV, and CV croſſing at V, and draw the Lines RV, TV, and AV. Thus far we go along with the laſt Chapter.

3. If we take the example in the ſeventh Chapter, that plain is the upper face of an Eaſt Incliner, whoſe Elevation is 37 *gr.* 26 *min.* and ſo much doth this Line T A reach unto in the Line of Latitudes: the Plains difference of Longitude is 54 *deg.* 2 *min.*

4. Count the Plains difference of Longitude from O towards A15, B30, C45, B60, A75: the number in that Circle which is neareſt, yet leſs than

54 *de.*

54 *de.* 2 *m.* the difference of Longitude, which number will be 45 *deg.* or 3 Hours ſtanding at C 45, the reſt or difference of the greater number above the leſſer, which is 9 *deg.* 2 *min.* count from O towards *m*, and there lay the Thread.

5. From C 45 (before found) to the Threads interſection with the Line (that iſſueth out from C 45, namely) C 45 *e*, take the diſtance, and with this length prick down the two Hour points of 12 and 6, upon the Plain from V to 12 and from R to 6. —— The reſt of the Hour diſtances muſt be taken from the reſpective points O o. A 15, B 30, to the Threads interſections with their proper Lines; which Lines are noted with the ſame Letters whereon the one foot of the Compaſſes ſtandeth, and the lengths ſo taken muſt be pricked down from V towards T and from R towards V.

Here by the way obſerve, that becauſe this plain is an Eaſt-incliner, the face of it looketh toward the Weſt, and then if you imagine the true ſcituation of this Dial upon the plain whereon it muſt ſtand, you will eaſily conceive that the Line of 12 is to ſtand on the right hand from the Line A V. and ſo the Line of 6 on the left hand, whereas if this plain had faced toward the Eaſt, the Line of 12 muſt have ſtood on the left hand, and ſix on the right hand. Your own conceit, together with the precepts of the Chapter following, muſt help in this, and in other things concerning the right ſcituating of the lineaments of your Dial.

To proceed then,

In the ſame manner you muſt take the diſtance from

O o	to the Threads interſection with the Line	O *n*	and ſet it upon the Plain from V to	3	and from R to	9
A 15		A *e*		2		8
B 30		B *r*		1		7
C 45		C *e*		12		6
B 60		B *n*		11		5
A 75		A *m*		10		4

6. Lay your rule to A, and draw A 10, A 11, A 12, A 1, A 2, A 3, A 4, A 5, A 6, A 7, A 8, A 9. Thus have you twelve Hours, and if you extend theſe beyond the Center, you ſhall have the whole 24 Hours, of which number you may take thoſe that ſhall be fit for the Plain in this ſcituation.

7. For the half Hours add 7 *de.* 30 *m.* to the difference of Longitude which in this Example was 54 *de.* 2 *m.* the ſum will be 61 *de.* 32 *m.* from whence taking 15 *deg.* as often as may be, or taking the greateſt number of the Circle O A B C B A (which is both leſs, and yet neareſt to it, namely 60) there will remain 1 *deg.* 32 *m.* to which counted from O towards *m* muſt the Thread be laid. —— Then take off the lengths from the ſame points O A B C B A, unto the interſections which the Thread makes with the Croſs Lines; always remembring to keep the proper Lines, namely thoſe that are noted with the ſame Letters, and that do iſſue from that point whereon the foot of the Compaſſes ſtandeth, and you ſhall by this work ſet down the half hours.

8. For the Quarters of Hours add 3 *deg.* 45 *min.* and for the three quarters of Hours add 11 *deg.* 15 *m.*

to the plains difference of Longitude and to thoſe places lay the Thread, and take out the diſtances from the points O A B C B A to the Threads interſections with the correſpondent Lines, and ſo you ſhall find points for your Quarters of hours alſo.

CHAP. XII.

How to place the Dial in a right Scituation upon the Plain.

AFter the Hour Lines are drawn by the laſt Chapter, they are to be placed in a right ſcituation upon their Plain. Which to do, upon ſome Plains is more difficult than the Deſcription of the Dial it ſelf. To give ſome directions herein, I have added this Chapter, where you have 9 Queſtions with their Anſwers, giving light ſufficient to what is here intended and required: but firſt be admoniſhed of three things.

1. That the inclination mentioned Chap. 8. is the very ſame in Uſe with the Proſthaphæretical ark mentioned Chapter 9. And therefore when I mention the Proſthaphæretical ark, becauſe it is of moſt frequent uſe, you muſt remember I mean both the Proſthaphæretical ark, Chap. 9, and the Inclination, Chap. 8.

2. That theſe rules, though given primarily for places of North-latitude, lying within the Temperate, Torrid, and Frigid Zones, yet are alſo as true, and may be applied to all places of South-latitude,

tude, if we exchange the names of North and South, for South and North.

Here by the way note, that the North part of the Torrid Zone extendeth from 0 degrees of Latitude to 23 *gr.* 30 *min.* the Temperate Zone reacheth from 23 *gr.* 30 *min.* to 66 *gr.* 30 *min.* the Frigid Zone extendeth from 66 *gr.* 30 *min.* to 90 *gr.* of Latitude. And ſo I come to the 9 Queſtions.

1. *What Pole is elevated above the Plain.*

Upon all Upright Plains declining from the North: Upon the upper faces of all Eaſt or Weſt incliners: Upon the upper faces of all North-incliners, whoſe Proſthaphæretical ark is leſs than the Latitude of the place: On the under faces of all North-incliners, whoſe Proſthaph. ark is greater than the Latitude of the Place; and on the upper faces of all South-incliners, The North pole is elevated. And therefore contrarily,

Upon all Upright Plains declining from the South: On the under faces of all Eaſt and Weſt, and South-incliners: On the under faces of all North-incliners, whoſe Proſthaphæretical ark is leſs than the Latitude of the place: On the upper faces of all North-incliners, whoſe Proſthaphæretical ark is greater than the Latitude of the place, The South pole is elevated.

2. *What part of the Meridian aſcendeth or deſcendeth from the Horizontal Line of the Plain?*

In all Upright Plains the Meridian lyeth in the Vertical Line, and if they decline from the South it deſcendeth, if from the North it aſcendeth.

Upon both faces of Eaſt and Weſt incliners the Meridian lyeth in the Horizontal Line.

In all North-incliners, the North part of the Meridian aſcendeth, the South part deſcendeth: in all South incliners the South part of the Meridian aſcendeth, the North part deſcendeth: upon both upper and under faces. And if theſe North and South incliners be direct, then the Meridian lyeth in the Vertical Line, and ſo maketh a right angle with the Horizontal Line: but if they decline, then the Meridian on the one ſide maketh an acute angle with the Horizontal Line.

3. *To which part of the Meridian is the ſtyle with the ſubſtyle to be referred, as making with it an acute angle?*

The ſtyle is the cock of the Dial; the ſubſtyle is the Line whereon it ſtandeth, ſigned out in the former deſcriptions by the letters A V.

In all Plains whereon the North pole is elevated, it is referred to the North part of the Meridian, and maketh an acute angle therewith.

In all Plains whereon the South pole is elevated, it is referred to the South part of the Meridian, and is to make an acute Angle therewith.

Except here only thoſe South-incliners, whoſe Proſthapharetical ark is more than the complement of your Latitude: for on theſe plains the ſubſtile ſtandeth on that part of the Meridian, whoſe denomination is contrary to the Pole elevated above the Plain. For on the upper faces the North pole is elevated, but the ſubſtyle ſtandeth toward the South end of the Meridian: and on the under faces the South pole

is

is elevated, but the ſubſtyle lyeth toward the North end of the Meridian.

Note here, that in South-incliners whoſe Proſthaphæretical ark is equal to the complement of your Latitude, the ſubſtyle lyeth ſquare to the Meridian upon the Line of *6* a clock; which Line in ſuch plains always lyeth perpendicular to the Meridian Line. Amongſt theſe falleth the Equinoctial plain.

4. *On which ſide of the Meridian lyeth the ſubſtyle?*

In all direct plains it lyeth in the Meridian. In all Decliners it goeth from the Meridian toward that coaſt which is contrary to the coaſt of the plains declination.

And ſo do all Hours alſo go upon the Plain to that coaſt which is contrary to the coaſt whereon they are; As all the morning or Eaſtern Hours go to the Weſtern coaſt of the Plain, and all the Evening or Weſtern Hours go to the Eaſtern Coaſt of the Plain. Which being obſerved will be a great help to place them aright.

5. *What Plains have the Line of* 12 *upon them, and which not?*

All upright Plains, in all Latitudes whatſoever, declining from the South have the Line of 12; and decliners from the North in the temperate Zone have it not, but in the other Zones they alſo have it.

The upper faces of Eaſt and Weſt incliners in all Latitudes have it, the under faces have it not.

The upper faces of all North incliners whatſoever have it; their under faces in the Temperate Zone want.

want it, in the Frigid Zone have it, and in the Torrid Zone likewiſe if the Proſthaphæretical ark be greater than the Suns leaſt North Meridian altitude, but if it be leſs they want it alſo.

For South-incliners, conſider the Suns greateſt and leaſt Meridian altitude upon the South coaſt. For if the Proſthaphæretical ark be ſuch as falleth between them, that is, if it be greater than the leaſt, or leſs than the greateſt, then have both ſides the Line of 12 upon them; but if it be leſs than the leaſt, then doth the under face want it univerſally, and the upper face alone hath it: if greater than the greateſt, then doth the upper face want it, and the under face alone hath it: Except in the Frigid Zone where the upper face hath it alſo, by reaſon of the Suns not ſetting there for a time.

6. Whether the North or South part of the Meridian ſerveth for the Line of 12?

In thoſe Plains that have the Line of 12, where the North pole is elevated, there the North part of the Meridian ſerveth for 12. and where the South pole is elevated, there the South part of the Meridian ſerveth for the Line of 12 or midday.

Except, in all Latitudes, the under faces of thoſe South-incliners, whoſe Proſthaphæretical ark falleth between the Suns greateſt and leaſt Meridian altitudes, for in them the South pole is elevated, but the North part of the Meridian ſerveth for the Line of 12.

Except in ſpecial thoſe Upright Plains in the Torrid-zone which look toward the North, and the Under faces of North-incliners alſo, whoſe Proſthaphæ-

haphæretical ark is greater than the leaſt North-meridian-altitude; for theſe have the South or lower part of the Meridian ſerving for 12, though the North pole be elevated.

7. *which way the ſtyle pointeth, and how it is to be placed?*

In Plains where the North pole is elevated, it pointeth up towards it; and where the South pole is elevated, it pointeth down towards it.

The ſtyle lyeth perpendicularly over the ſubſtyle, noted in the former figures with A V, and is to be elevated above it to ſuch an angle as the Elevation of the Pole above the Plain ſhall be found to be by the 6, 7, 8, and 9 Chapters.

8. *When is it that that part of the Meridian next the ſubſtyle, and the Line of twelve do go contrary ways?*

In all Latitudes, Upon the Upper faces of South-incliners, whoſe Proſthaphæretical ark is greater than the complement of the Latitude, but leſs than the Suns greateſt South Meridian altitude: And on the Under faces of thoſe South-incliners alſo, whoſe Proſthaphæretical is leſs than the complement of the Latitude, but greater than the Suns leaſt South meridian altitude: In the Torrid-Zone alone you muſt add hither alſo, North upright Plains, and thoſe North-incliners on the Under face, whoſe Proſthaphæretical ark is greater than the leaſt North-meridian altitude of the Sun; for theſe have the Line of midday ſtanding on that coaſt which is contrary to the coaſt of that part of the Meridian next the ſubſtyle, and none elſe. The line of 12. I call

call here the Line of midday becauſe in the Frigid-Zone, where the Sun ſetteth not in many days together, there are two twelves, the one anſwering to our midday, and the other to our midnight: and ſo all Upper faces of South-incliners, whoſe Proſthapharetical ark falleth between the leaſt and greateſt South meridian altitudes, have there two 12 a clock Lines upon them.

9. How much the Meridian Line aſcendeth or deſcendeth from the Horizontal Line?

The quantity of the Angle is to be found upon the Quadrant, by help of the Line of Tangents and the equal Limb. Thus,

Count the Complement of the Plains Inclination upon the Limb, and thereto apply the Thread. Then,

1. Either, Take the Complement of the Plains declination, and fitting it between the Scale of Tangents and the Thread, the foot that is upon the Scale will (thereupon) give the Meridians Aſcenſion.

2. Or, Count the declination upon the Scale and take the leaſt diſtance from thence to the Thread, and if you meaſure that diſtance upon the Tangent Scale, you ſhall find the Complement of the Meridians Aſcenſion.

In the example of the 9. Chap. taking the Upper faces of that Plain, I find the Meridian to aſcend above the Horizontal Line 33 *gr.* 41 minutes.

¶ *Theſe*

¶ *These directions are sufficient for the bestowing of every Line into its proper place and coast. As may be seen in the Example of the ninth Chapter.* For,

First, upon the upper face of that North incliner, because his Prosthaphæretical ark *16 gr. 6 min.* is less than *52 gr. 30 min.* the Latitude of the place, therefore the North pole is elevated above it: by the Answer to the first Quest.

2. Because it is a North-incliner, therefore the North part of the Meridian ascendeth above the Horizontal Line, by the answer to the second Question.

3. Because the North pole is elevated, therefore the Style with the substyle maketh an acute angle with the North end of the Meridian, by the Answer to the third Question.

4. Because this Plain declineth toward the West, therefore the substyle lyeth on the East-side of the Meridian, and so do the Hours of the afternoon: by the Answer to the fourth Question.

5. This Plain, being the Upper face of the North-incliner, will have the Line of 12 to be drawn upon it, by the Answer to the fifth Question.

6. Because the North pole is elevated, therefore the North part of the Meridian serveth for the Line of 12: by the Answer to the sixth Question.

7. Because the North pole is elevated, therefore the style pointeth upward toward the North pole: by the Answer to the seventh Question.

8. That part of the Meridian next the Subſtyle, and the Line of 12 are both one, and ſo therefore go both one way: by the Anſwer to the eighth Queſtion.

9. By the ſecond the Meridian Line aſcendeth, and the quantity of the aſcent is 33 *gr.* 41 *min.* above the Horizontal Line: by the Anſwer of the ninth Queſtion.

Thus you ſee every doubt cleared in this example: the like may be done in all others.

CHAP. XIII.

The making and placing of Polar Plains.

FIG. IV.

POlar Plains are thoſe North incliners, whether direct or declining, that lye in the Pole, and ſo have no Elevation of the Pole above them, as the direct North and South polar, the Eaſt and Weſt upright Plains, and infinite others declining betwixt both. You may know them by the 8 and 9 Chapters, as is there intimated.

Theſe Plains may have Dials deſcribed upon them by this Quadrant, but the better way is the common way, to protract them by an equinoctial circle, for otherwiſe the ſtyle will be alway of one diſtance

diſtance from the Plain, be the Dial greater or leſſer.

The Polar plains that decline, before they can be deſcribed, muſt have their *New-inclination* known, and then their delineation will be eaſie, the manner of it may be ſeen in this Example.

Suppoſe the upper face of a North-inclining Plain, lying in the Latitude of 52 *gr.* 30 *min.* to decline from the South toward the Eaſt 68 *gr.* and to incline towards the North 73 *gr.* 57 *min.* you ſhall find by the ninth Chapter, the Proſthaphæretical ark to be 52 *gr.* 30 *min.* the ſame with the Latitude of the place, and therefore you may conclude this plain to be Polar. By the ſame Chapter you ſhall find the New-inclination to be 63 degrees.

When you have theſe you may draw your Semicircle A B 4, and divide it into 12 equal parts for the Hours: ſo ſigning the New-inclination 63 degrees from A to B, draw C B: and ſuppoſing the altitude of your ſtyle to be C D, through D draw the perpendicular D 12; and where the Lines draw from C through the diviſions of the ſemicircle do cut the Line D 12, there raiſe perpendiculars for the Hours, and ſo finiſh it up as the manner is. The ſtyle lyeth directly over and parallel to the ſubſtyle C B, and the diſtance of it from the plain is C D, and in this Example the ſubſtyle C B ſtandeth from the Line of 12 Weſtward, becauſe the plain declineth Eaſtward, according to the Rules in the former Chapter, and ſo do the morning Hours alſo.

For the placing of the Dial in a true ſite upon the Plain, you ſhall find by the anſwer to the 9 Queſt. in the former Chapter, that the Meridian aſcendeth 55 *gr.* 38 *min.* for other neceſſaries, the precepts of the former Chapter will direct you. Only obſerve that in Upright Eaſt and Weſt plains, the Line of 6 is always the ſubſtyle, and it aſcendeth above the North end of the Horizontal Line, as much as the Latitude of the place cometh to.

A N

AN APPENDIX

Shewing a ready way to find out the Latitude of any place by the Sun.

BEcauſe in the third Chapter, and quite through this Treatiſe, the Latitude of the place is ſuppoſed to be known, when as every one perhaps cannot tell which way to find it out; I thought good therefore to add this *Appendix* as a ready help to ſhew how it may be attained ſufficiently for our purpoſe. Know then that for the finding out of the Latitude of a place by the Sun, theſe things are required.

1. *To find the Meridian Line.*

The readieſt way to find the Meridian Line is by the North-ſtar. This ſtar is within 2 *deg.* 37 *min.* of the North-pole. The North-pole lyes very near between Allioth, or the root of the great Bears tail, and this ſtar; You may therefore imagine where the Pole is, if you conceive a right Line drawn from the Pole-ſtar to Allioth, and by your imagination ſuppoſe $\frac{2}{3}$ pats of the diſtance of the next ſtar of the little Bears tail from the Pole-ſtar towards Allioth, for there is the very Pole-point.

Now

Now then if you ſet up two Poles aſlope, and from the tops of them hang two cords with weights at the ends of them, and turn them till you ſtanding on the South-ſide of them may ſee them both together with the Pole-point, as it were all in one Line, then be ſure theſe two cords do hang in the Meridian Line, or very near it, yea ſo near it, that though you ſhould err 3 degrees herein (wherein you need not to err one degree;) yet will not the Meridian altitude in theſe Climates (eſpecially more Northward,) fail you above 3 minutes, which is near enough to our purpoſe. I have here given you the chief ſtars of the great and little Bears, that by them you may come to know the ſtars uſed in this obſervation, and ſo find the very Pole-point it ſelf.

2. *To find the Suns Meridian altitude.*

Obſerve diligently about noon when the ſhadow of the South cord ſhall fall upon the North cord, for then is the Sun in the Meridian. At that inſtant obſerve the Suns altitude ſtedily and carefully, for that is the Meridian and greateſt altitude of the Sun for that day.

3. *To find the Suns declination.*

For this purpoſe the limb hath the characters of the 12 Signs fixed to each 30 degree, and a ſcale of declinations under the limb noted with M N. The Scale is divided by this Table; for look what *degr.* and *min.* of the Eclipt. do anſwer to the *degr.* of declination in the Table, the ſame are to be numbred in the limb, and by a ruler applied to them, the degrees of declination are drawn upon the Scale.

A Table to make the Scale for the declination of every part of the Ecliptick.

Deg. of declin.	Deg. of the ecl.	Deg. of declin.	Deg. of the ecl.	Deg. of declin.	Deg. of the ecl.
0. 0	0. 0	4. 0	10. 4	8. 0	20. 26
15	0. 38	15	10. 43	15	21. 6
30	1. 15	30	11. 21	30	21. 46
45	1. 53	45	11. 59	45	22. 26
1. 0	2. 31	5. 0	12. 37	9. 0	23. 6
15	3. 8	15	13. 16	15	23. 46
30	3. 46	30	13. 54	30	24. 27
45	4. 24	45	14. 33	45	25. 8
2. 0	5. 1	6. 0	15. 12	10. 0	25. 49
15	5. 39	15	15. 51	15	26. 30
30	6. 16	30	16. 30	30	27. 12
45	6. 55	45	17. 8	45	27. 53
3. 0	7. 33	7. 0	17. 48	11. 0	28. 36
15	8. 10	15	18. 27	15	29. 17
30	8. 48	30	19. 6	30	30. 0
45	9. 26	45	19. 46	45	30. 43
12. 0	31. 26	16. 0	43. 44	20. 0	59. 4
15	32. 9	15	44. 34	15	60. 14
30	32. 52	30	45. 25	30	61. 26
45	33. 36	45	46. 17	45	62. 41
13. 0	34. 21	17. 0	47. 9	21. 0	66. 00
15	35. 5	15	48. 3	15	65. 22
30	35. 50	30	48. 57	30	66. 48
45	36. 35	45	49. 52	45	68. 20
14. 0	37. 21	18. 0	50. 48	22. 0	69. 58
15	38. 7	15	51. 45	15	71. 44
30	38. 54	30	52. 43	30	73. 41
45	39. 41	45	53. 43	45	75. 53
15. 0	40. 28	19. 0	54. 44	23. 0	78. 30
15	41. 16	15	55. 47	15	81. 52
30	42. 05	30	56. 50	30	90. 0
45	42. 54	45	57. 56	FINIS.	

Before

Before you can find the Declination, you muſt know the Suns place, and for ſuch as know not the uſe of the Aſtronomical Tables, an Almanack will ſerve, where for every day at noon, you ſhall find the Suns place in ſigns, degrees and minutes. The *degr.* and *min.* muſt be numbred in their Signs upon the Limb, and the Thread applyed thereto will ſhew the Declination anſwerable. As for example. *September* 21. 1637 in the Almanack for this year, the Sun is found to be in 8 *gr.* 30. *min.* of ♎. In the Quadrants Limb I look for the Sign ♎ and number there, 8 *gr.* 23 *min.* whereto apply the thread, I find it to cut in the ſcale of Declinations 3 *gr.* 20 *min.*

4. *By the Meridian Altitude, and declination of the Sun had; how to find the Latitude of the Place, or the Elevation of the Pole above the Horizon.*

Compare the Suns Meridian altitude and declination together, and if the Sun be in a North Sign as ♈♉♊♋♌♍, then ſubſtract the declination out of the Meridian altitude, ſo ſhall the difference give you the height of the Equinoctial. But if the Sun be in the South Signs, as ♎♏♐♑♒♓, then add the declination to the Meridian altitude, ſo ſhall the ſum give you the height of the Equinoctial, which being taken out of the Quadrant or 90 degrees, leaveth the Latitude of your place, or the Elevation of the Pole above your Horizon.

For Example. Upon the 21 of *September* 1637. I obſerved the Suns altitude in the Meridian to be

be 34 *gr.* 10 *min.* Upon which day I find the Suns place to be (as before) 8 *gr.* 23 *min.* of ♎, and the declination 3 *gr.* 20 *min.* And becauſe the Sun is in a South ſign, I add this declination and Meridian altitude together; the ſum 37 *gr.* 30 *min.* is the altitude of the Æquator, and this taken out of 90 degrees leaveth 52 *gr.* 30 *min.* for the Latitude of *Coventry.*

FINIS.

THE

INSTRUMENTAL WORK,

Of all the foregoing

TREATISE

OF

Mr. *SAMUEL FOSTERS*;

Performed by

ARITHMETICAL CALCULATION:

Wherein *Canons* are preſcribed, for the effecting thereof (more exactly) by the Tables of Artificial Sines and Tangents.

ALL that the *Inſtrument* is applyed to in the forementioned *Treatiſe*, may be performed by *Calculation*, and thoſe *Lines* upon the *Inſtrument*, will not only perform what is there by Mr. *Foſter* mentioned, but divers other *Uſes* alſo may be made of them; as namely, all *Caſes* which fall under the *Fourth Axiome* of *Sphærical Trigonometrie*, by the Line of *Verſed Sines* (as himſelf hath mentioned in the *Uſe of his Sector*) and all other *Propoſitions* wrought by *Sines* and *Tangents*, may be effected by the *Tangent Line* and the *Equal Limb*;

by which *Lines*, he hath (in this his *Treatiſe*) ſhewed how to work ſuch Concluſions as were pertinent to the making of *Sun-Dials* only.

Now for the working of all which concluſions, I have here framed *Canons* whereby all of them may be performed (with the moſt exactneſs) by the *Tables* of *Artificial Sines* are *Tangents*, which *Tables* are in every Mans hands, or may be had when the *Inſtrument* is wanting.

The Chapters in Mr. *Foſters* Book, which require *Inſtrumental Operation*, are theſe following, *viz.* The *Third*, *Sixth*, *Seventh*, *Ninth*, *Tenth*, *Eleventh*, and *Twelfth*; the performing of the Works of all which Chapters *Arithmetically* I ſhall here ſhew in theſe following Sections. And

Sect. I. *For the Work of the* III *Chapter.*

THe work of this Chapter is,

§ 1. *To find the Suns Azimuth.*

§ 2. *To find the Hour of the Day.*

Probl. I.

The Latitude of the Place, the Declination of the Sun, and the Altitude of the Sun given, to find the Suns Azimuth from the South.

Let the *Latitude* be 32 *deg.* 30 *min.* The Suns *Declination* 11 *deg.* 31 *min.* North, and the *Altitude* 30 *deg.* 45 *m.*

Firſt, Add the Complement of the *Latitude*, the Complement of the *Altitude*, and the Complement

ment of the *Declination*, all three together, into one *Sum*, and take the half thereof, from which *half Sum* ſubduct the Complement of the *Declination*, and note the *difference*, as in the *Example* following.

	de.	*m.*		*de.*	*m.*
Latitude----	52	30	Complement	37	30
Declination	11	31		78	29
Altitude----	30	45		59	15
			The Sum	175	14
			Half Sum	87	37
			Complement of the Suns declination Sub-	78	29
			The Difference	09	08

This done, the Canon or Proportion will be

(1) As the Sine of 90 *d.* 10

Is to the Co-Sine of the Altitude 59 *d.* 15 *m.* —— 9. 934198
So is the Co-Sine of the Latitude 37. *d.* 30 *m.* —— 9. 784447
To the Sine of 31 *de.* 33 *m.* —— 9. 718645

(2) As the Sine of 31 *de.* 33 *m.* —— 9. 718645

Is to the Sine of the half Sum 87 *de.* 37 *m.* —— 9. 999624
So is the Sine of the difference 09 *de.* 08 *m.* —— 9. 200666
19. 200290
To this Sine —— 9. 481645
To which add the Sine of 90 *deg.* —— 10. 000000
The Sum is —— 19. 481645
The half Sum is —— 9. 740822

Which is the Sine of 33 *de.* 24 *min.* the Complement whereof is 56 *de.* 36 *m.* and that doubled is 113 *deg.* 12. *m.* which is the Suns *Azimuth* from the *North* part of the Meridian, which if you take from 180 *deg.* there will remain 66 *deg.* 48 *min.* which is the Suns *Azimuth* from the *South*.

And

And according to this *Analogie* or proportion, you may moſt exactly, at any time, and in any Latitude find the *Azimuth* of the Sun from the *North* or *South*.

Probl. II.

The Latitude of the Place, the Declination and Altitude of the Sun given, to find the Hour from Noon.

Let the *Latitude* be 51 *de.* 30 *min.* the Suns *Declination* 20 *deg.* 00 *m.* and the Suns *Altitude* 12 *d.* and let the time of the day be required.

Firſt, Add the Complement of the *Latitude*, the Complement of the *Declination*, and the Complement of the Suns *Altitude*, all three into one *Sum*, and from *half that Sum* ſubduct the *Complement* of the Suns *Altitude* as you ſee here done, and note the *Difference*.

		de.	*m.*		*de.*	*m.*
	Latitude	51	30	Complement	38	30
Suns	Declination	11	31		78	29
	Altitude	35	00		55	00
	The Sum				171	59
	Half Sum				85	59
	Complement of Altitude ſubducted				55	00
	Difference				30	59

Being thus prepared, work as followeth.

(1) As Radius Sine 90 *de.* 10.

To Co-Sine of Suns declination 78. *d.* 29 *m.* —— 9. 991167
So Co-Sine Latitude 38 *d.* 30 *m.* —— 9. 794149

To the Sine of 37 *d.* 36 *m.* —— 9. 785316

(2) As

(2) As the Sine of 37 *d.* 36 *m.* ——— 9. 785316

To the Sine of the half Sum 85 *d.* 59. ——— 9. 998932
So is the Sine of the difference 30 *d.* 59 *m.* ——— 9. 711629

19. 710561

To the Sine of 57 *d.* 20 *m.* ——— 9. 925245

To which add the Radius, the Sum is ——— 19. 925245
The half Sum is the Sine of 66 *d.* 34 *m.* ——— 9. 962612

Whose Complement is 23 *de.* 26 *m.* the double whereof is 46 *de.* 52 *m.* which is the *Hour* from *Noon*, which is either 7 *m.* after 9 in the *Morning*, or 53 *m.* after 2 in the *Afternoon*.

Sect. II. *For the Work of the* VI *Chapter.*

THE Work of this Chapter is, in *Upright Declining Plains.*

§ 1. *To find the Plains Difference of Longitude.*

§ 2. *To find the height of the Pole above the Plain.*

Both which by Calculation may be thus effected.

Example, In the Latitude of 52 *d.* 30 *m.* Let an Upright Plain decline from the North or South 55 *de.* 30 *m.*

(1) *For the Plains difference of Longitude.*

As the Sine of the Latitude 52 *de.* 30 *m.*--9. 899467
To Radius 90 *d.* ——— 10.
So is the Tangent of the Plains Declination 55 *deg.* 30 *m.* ——— 20. 162686

To the Tangent of 61 *de.* 23 *m.* ——— 10. 263219
Which is the Plains Difference of Longitude.

(2) *For*

(2) *For the height of the Pole above the Plain.*

As the Sine of 90 *d.* —— 10.
To the Co-sine of the Latitude, 37 *d.* 30 *m.* 9. 784447
So is the Co-Sine of the Declination 34 *d.* 30 *m.* —— 9. 753128

To the Sine of 20 *de.* 10 *m.* —— 9. 537575
Which is the height of the Pole above the Plain.

Sect. III. *For the Work of the* VII *Chapter.*

THE Work of this Chapter is, In *East and West Inclining Plains.*

§ 1. § 2. To find { *The Plains difference of Longitude.* / *The height of the Pole above the Plain.*

Both which by Calculations may be found as followeth,

Thus in the Latitude of 52 *de.* 30 *m.* If an East or West Plain do Incline to the Horizon 40 *deg.*

(1) *For the Plains difference of Longitude.*

As the Sine of 90 *d.* —— 10.
To the Co-Sine of the Latitude 37 *d.* 30 *m.* —— 9. 78444
So is the Co-Tangent of the Inclination 50 *d.* —— 10. 07618

To the Tangent of 35 *d.* 58 *m.* —— 9. 86062

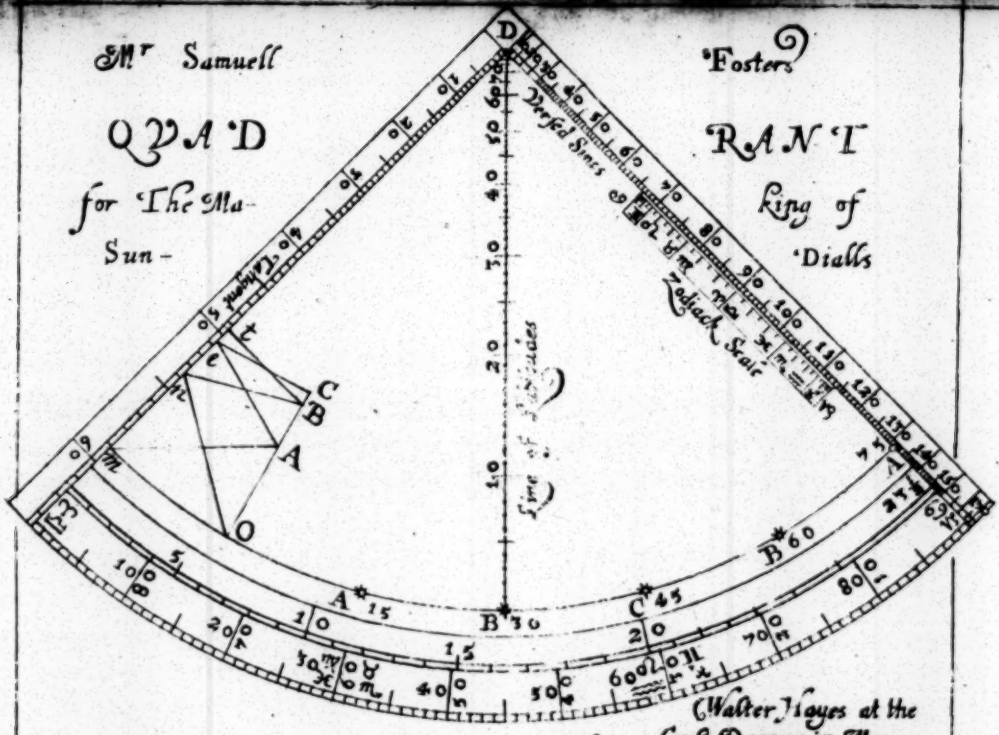
Whose Complement 54 *d.* 2 *m.* is the Plains Difference of Longitude.

(2) *For the height of the Pole above the Plain.*

As the Co-Sine of the Difference of Longitude 35 *d.* 58. *m.* —— 9. 76887
To the Sine of 90 *d.* —— 10.
So is the Co-Tangent of the Latitude 37 *d.* 30 *m.* —— 10. 88498

To the Tangent of 52 *d.* 34 *m.* —— 10. 11611

Whose



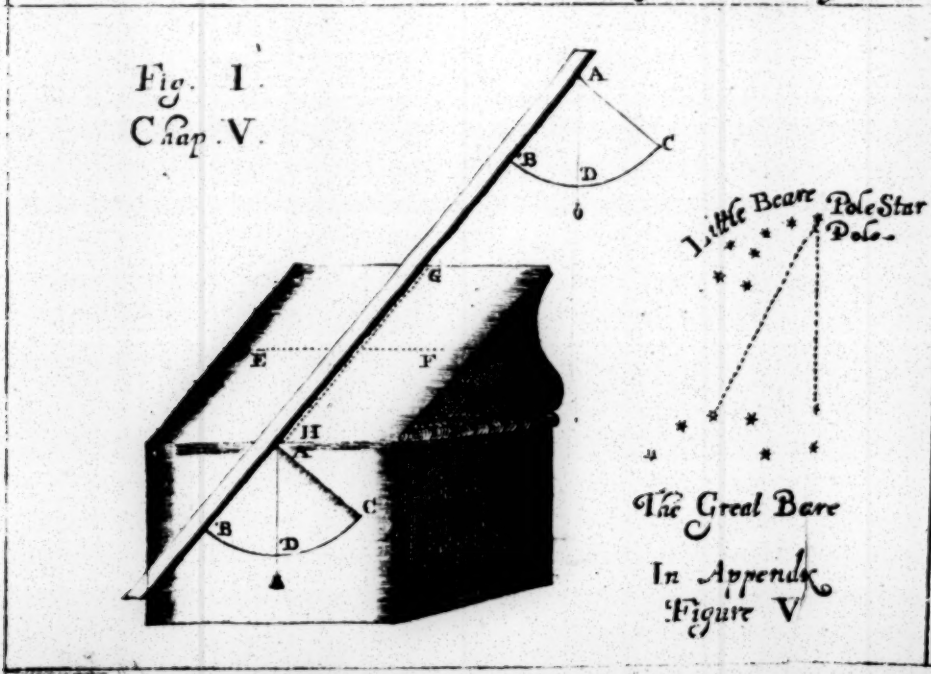


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Figure II Chap: X

An Horizontall Diall for the Latitude of 52 gr 30

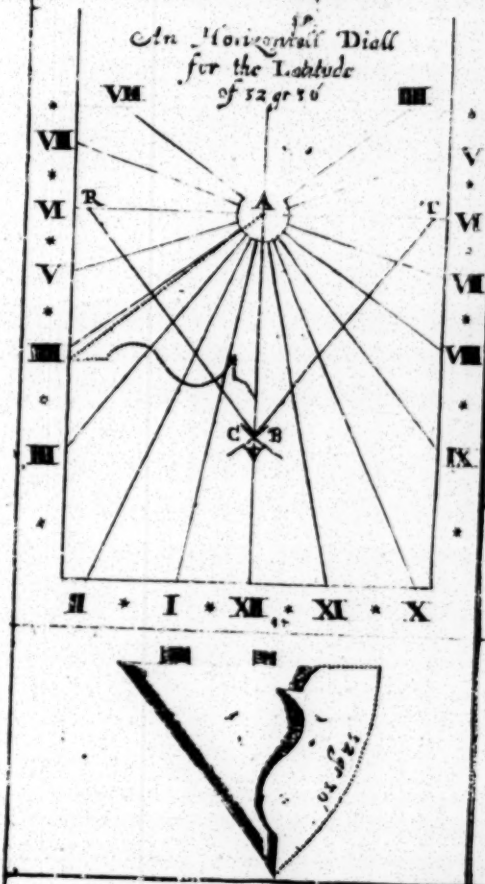


Figure III Chap XI

A Plaine Inclining Eastward 40 gr 0′ Latitude 52 30′

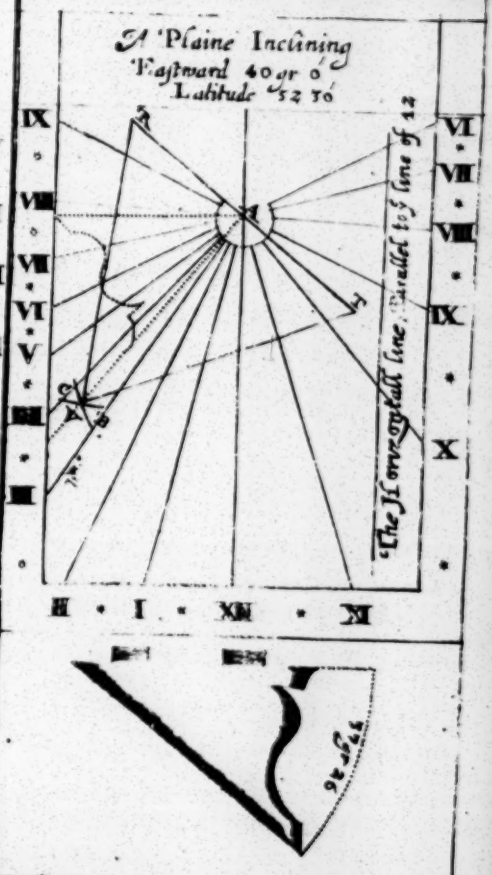
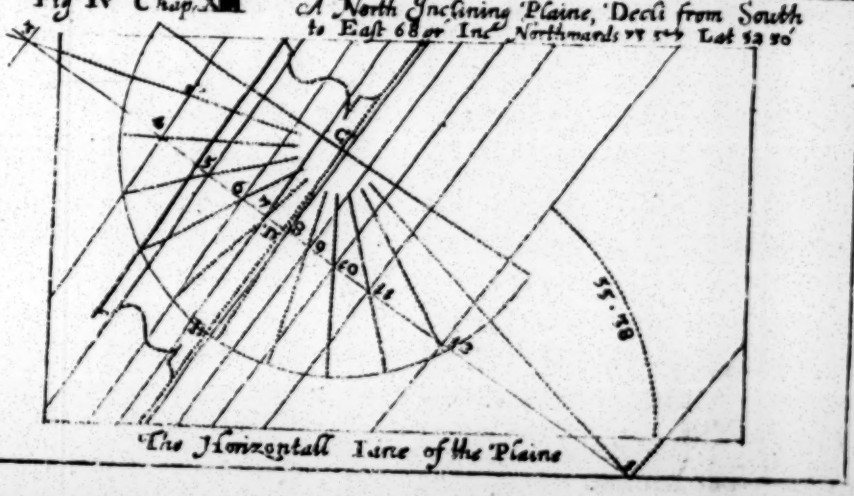


Fig IV Chap XII

A North Inclining Plaine, Decli from South to East 68 gr Inc Northwards 37 54 Lat 52 30′



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Whoſe Complement 37 *de.* 26 *m.* is the Elevation of the Pole above the Plain.

Sect. IV. *For the Work of the* IX *Chapter.*

THE Work of this Chapter is, in *Declining Inclining Plains.*

§ 1. §
§ 2. § To find the { *Proſthaphæretical Ark.*
§ 3. § *Plains New Inclination.*
§ 4. § *Difference of Longitude.*
Elevation of the Pole above the Plain.

All which by the following *Analogies* may be found.

Example, In the Latitude 52 *d.* 30 *m.* Let a Plain decline from the South towards the Weſt 60 *deg.* and Incline towards the North 30 *deg.*

1. *For the Proſthaphæretical Ark.*

As the Sine Complement of the Declination 30 *d.* —— 9. 69897
To Radius 90 *d.* —— 10.
So the Co-Tangent of the Inclination 60 *d.* —— 20. 23856

To Co-Tangent Proſthaphæret. Ark 73 *d.* 54 *m.* —— 10. 53959

Whoſe Complement 16 *d.* 6 *m.* is the Proſthaphæretical Ark ſought.

2. *For the Plains New Inclination.*

As the Sine of 90 *d.* —— 10.
To the Sine of the Proſthaphæretical Ark 16 *d.* 6 *m.* —— 9. 44297
So is the Tangent of the Plains Declination 60 *d.* —— 0. 23856

To the Tangent of 25 *d.* 40 *m.* —— 9. 68153

Which is the Plains New Inclination.

The New Latitude is found by this IX Chapter to be 36 *d.* 24 *m.* Then

3. *For the Plains difference of Longitude.*

As Radius Sine 90 *deg.* —— 10.
To the Co Sine of New Latitude 53 *d.* 36 *m.* —— 9. 90574
So Co-Tangent New Inclination 64 *d.* 20 *m.* —— 10. 31826

To Tangent 59 *d.* 10 *m.* —— 10. 22400

Whose Complement 30 *d.* 50 *m.* is the Plains difference of Longitude.

4. *For the Poles Elevation.*

As the Co-Sine of Difference of Longitude 59 *d.* 10 *m.* —— 9. 93382
To Radius 90 *de.* —— 10.
So Co-Tangent of New Latitude 33 *d.* 36 *m.* —— 10. 13238

20. 13238

To Tangent 57 *d.* 40 *m.* —— 10. 19856

Whose Complement 32 *de.* 20 *min.* Is the Poles Elevation above the Plain.

Sect. V. *For the Work of the* X *Chapter.*

THE Work of this Chapter, is, *To draw the Hour Lines,* (or to find their distances) *upon the Horizontal, the full North or South Plains, whither standing Upright or Inclining.*

In all Horizontal Plains the height of the Pole or stile is equal to the Latitude of the place, In the upright North or South it is equal to the Complement of the Latitude of the place; but in direct North or South Incliners you find the height of the Pole or stile above the Plain by the directions of the VIII Chapter.

The

The height of the Pole being known, the true Hour distances upon the Plain may be calculated by this *Analogie* following, *viz.*

As the Radius, Sine of 90 *de.* ——————————— 10.

Is to the Sine of the height of the Pole above the Plain 52 *d.* 30 *m.* for the Horizontal Dial, *Chap.* X. } ——— 9. 899467

So is the Tangent of 15 *deg.* the first Hours Equinoctial distance from 12 —— } ——— 9. 428052

To the Tangent of 12 *de.* 17 *m.* ——————————— 9. 327519

Which 12 *d.* 17 *m.* is the distance of the Hour Lines of 11 a Clock and 1 of the Clock from the Meridian, and by using the same Proportion for all the Equinoctial Hour distances, you shall find them to be such as this following Table affordeth.

Hours from the Meridian or 12			*True Hour distances upon the Plain.*	
	12		*d.*	*m.*
1		11	00	00
2		10	12	17
3	or	9	24	37
4		8	38	26
5		7	53	57
	6		71	20

And in this manner may the Hour distances be found upon all direct *North* or *South* Plains, whither *Upright* or *Inclining*, making the same use of the *Height of the Pole* or *Stile* above the Plain, as I have here done of 52 *d.* 30 *m.* the *Latitude*, for the *Horizontal* Plain, for *All Dial Plains in one Latitude, are Horizontal Plains to some Latitude or other in the world.*

Sect. VI. *For the Work of the* XI *Chapter.*

THE Work of this Chapter is, *To draw the the Hour Lines*, (or to find their diſtance) *upon all ſorts of Declining Plains, whether Erect or Inclining.*

We will take for our Example the Dial in this XI Chapter, which is of an Eaſt Plain Inclining to the Horizon 40 *deg.* in that Latitude of 52 *d.* 30 *m.* for which Plain, by the III. beforegoing we did find.

§ 1. *The Plains Difference of Longitude to be* 54 *d.* 02 *m.*

§ 2. *The height of the Pole above the Plain.* 37. 26

Theſe two being obtained, we now come to ſhew how the ſeveral Hour-diſtances from the ſubſtile (or Meridian of the Plain) upon the Plain, may be obtained, for which briefly thus, and this *Example* is general for all Plains whatſoever, which have *Centers.*

The Plains *difference of Longitude* being 54 *d.* 2 *m.* you are to conſider how many Equinoctial Hours and parts of an Hour are contained therein, that is, how many times 15 *deg.* for one Hour, which you ſhall find to be 9 Hours and 9 *d.* 2 *m.* Wherefore, this Plain being an Eaſt Inclining Plain, the ſubſtyle muſt ſtand between the Hour Lines of 3 and 4 in the Afternoon, becauſe the Face of the Plain looketh towards the Weſt.

This done, Subſtract 45 *deg.* (which is 3 Hours

diſtance upon the Equinoctial) from 54 *de.* 2 *m.* the *Plains difference of Longitude*, and there will remain 9 *d.* 2 *m.* which 9 *d.* 2 *m.* ſet down and over the head thereof write *Subſtyle*, as is done in this Table, and againſt it on the left hand write 9---3 for the Hours of 9 and 3 ----- Then, to 9 *d.* 2 *m.* add 15 *de.* the ſum is 24 *d.* 2 *m.* which write under 9 *d.* 2 *m.* and on the left hand of it write 10 ---- 2 for the Hours of 10 and 2, and ſo continuing the addition of 15 *deg.* you ſhall find 54 *d.* 2 *m.* (which is the Plains difference of Longitude) to ſtand againſt 12 of the Clock ----- In like manner, Subſtract 54 *d.* 2 *m.* from 60 *d.* or 4 Hours diſtance, and the remainer will be 5 *d.* 58 *m.* which write over the word *Subſtile*, and againſt it to the left hand write 4---8 for the Hours of 4 and 8, and and then by the continual addition of 15 *d.* to 5 *de.* 58 *m.* you ſhall find ſuch Equinoctial diſtances as are expreſſed in this Table, to which on the left hand write the correſpondent hours, as you ſee here done.

East Plain. d. m

Latitude ——— 54. 30
Difference of Longitude ——— 54. 02
Poles height ——— 37. 26

Hours	*Equinoctial diſtances* d.	m.	*True Hour diſtances on the Plain.* d.	m.
9 —— 3	80	58	75 —— 20	
8 —— 4	65	58	53 —— 44	
7 —— 5	50	58	36 —— 52	
6 —— 6	35	58	23 —— 48	
5 —— 7	20	58	13 —— 7	
4 —— 8	5	58	3 —— 38	
	Subſtyle			
3 —— 10	9	2	5 —— 31	
2 —— 11	24	2	15	10
1 —— 11	39	2	26	14
12	54	2	39	57
11 —— 1	69	2	57	46
10 —— 2	84	2	80	15

The Table being thus far prepared, we muſt next enquire the true Hour diſtances of each Hour from the

the *ſubſtyle* upon the *Plain*, which will be effected upon all *Plains* whatſoever, by this one general *Analogie* or *Proportion*, *viz.*

As the Radius, or Sine of 90 *de.*	10. 000000
Is to the Sine of the height of the Pole above the Plain 37 *deg.* 26 *min.*	9. 783787
So is the Tangent of 80 *de.* 58 *m.* (which is the Equinoctial Hour diſtance of 9 and 3 of the Clock.)	10. 798655
	0. 582442
To the Tangent of 75 *d.* 10 *m.*	10. 582442

Which is the true diſtance of the Hour Lines of 9 or 3 of the Clock upon the Plain from the Subſtyle——And thus repeating this Work, as often as is requiſite, till you have filled up your Table, you ſhall find ſuch Hour diſtances as this Table affordeth in the third Column, however, to make it more plain, take the *Example* of another Hours diſtance, *viz.* of the Hours of 2 and 10 a Clock.

As Sine 90 *de.*	10. 000000
To the Sine of the height of the Pole 37 *d.* 26 *m.*	9. 783787
So is the Equinoctial diſtance belonging to the Hours of 2 and 10. *viz.* 24 *d.* 2 *m.*	9. 649263
To the Tangent of 15 *d.* 10 *m.*	9. 433050

Which 15 *d.* 10 *m.* is the true Hour diſtance of the Hour Lines of 2 and 10 of the Clock upon the Plain from the Subſtyle, and the like is to be done for all the reſt as in the Table.

Sect.

Sect. VII. *For the Work of the* XII *Chapter.*

THE Work of the Ninth Paragraph of this Chapter, is to find, *How much the Meridian Line Aſcendeth or Deſcendeth from the Horizontal Line.*

The Example there is of a Plain declining from the North or South towards the Eaſt or Weſt 60 *de.* and Inclining to the Horizon Northward 30 *d.* Now to find the Meridians Aſcenſion or Deſcenſion. This is the Proportion.

As the Co-Sine of the old Inclination 60 *d.* —— 9. 937850
To Sine 90 *deg.* —— 10.
So Co-Tangent of the Plains Declination 30 *d.* —— 9. 761439
To the Tangent of 33 *d.* 40 *m.* —— 9. 761439

Which is the Meridians Aſcenſion.

And thus have you all the Inſtrumental Work of the foregoing Treatiſe of Mr. Foſters *Arithmetically performed.*

FINIS